pISSN 2319-2003 | eISSN 2279-0780

DOI: https://dx.doi.org/10.18203/2319-2003.ijbcp20261954

Original Research Article

Infographic-supported pharmacology teaching in undergraduate medical education: a qualitative study of student experiences

Shruti Singh[1], Rajesh Kumar Meena[1], Prashant Kumar Singh[2]*, Sourik Shee[1]

[1]Department of Pharmacology, AIIMS, Patna, Bihar, India
[2]Department of Surgery, AIIMS, Patna, Bihar, India

Received: 10 April 2026
Revised: 09 May 2026
Accepted: 19 May 2026

***Correspondence:**
Dr. Prashant Kumar Singh,
Email: drprashantks@aiimspatna.org

ABSTRACT

Background: Pharmacology is often perceived by medical students as cognitively demanding because of high information density and complex mechanistic reasoning. Infographics have emerged as visual tools that may support conceptual integration and reduce cognitive burden, yet qualitative evidence regarding how students experience infographic-supported pharmacology teaching remains limited.
Methods: A qualitative descriptive study was conducted among Phase 2 MBBS students during routine pharmacology teaching across five system blocks (autonomic nervous system, autacoids, cardiovascular, central nervous system, and endocrine pharmacology). Infographics were systematically developed, validated through expert consensus, and piloted before implementation. Following the intervention, 125 students provided narrative feedback through an anonymous survey. Data were analyzed using deductive thematic analysis guided by cognitive load, multimedia learning, and dual coding theories.
Results: Eight themes emerged and were organized into four overarching domains: cognitive learning impact, learner engagement, instructional design usability and recommendations. Students reported improved conceptual clarity, enhanced engagement, and efficient revision through infographic-supported learning. Visual structuring helped integrate mechanisms of action with clinical application. However, negative case analysis revealed that overly dense visuals could increase cognitive strain or encourage superficial learning. Students emphasized that infographics were most effective when integrated with interactive instructor guidance rather than used as standalone resources.
Conclusions: Carefully designed infographics may enhance conceptual integration, engagement, and revision efficiency in pharmacology education when aligned with principles of cognitive load management and active teaching. Their effectiveness depends on appropriate visual density and integration within active teaching strategies.

Keywords: Education, Medical, Undergraduate, Pharmacology/education, Infographics, Qualitative research, Cognitive load, Instructional design

INTRODUCTION

Pharmacology is often perceived by medical students as a demanding subject with high information density, abstract mechanistic reasoning, and difficulty in integrating foundational science with clinical decision-making. When teaching relies predominantly on text-dense lectures, students tend to adopt strategies that foster rote memorization over understanding. Educational theory suggests that content delivery methods should actively support schema formation by reducing unnecessary cognitive burden. Cognitive Load Theory (CLT) posits that learning is enhanced when extraneous cognitive load is minimized and working memory is redirected toward relevant knowledge organization.[1]

Complementing CLT, the Cognitive Theory of Multimedia Learning also emphasizes that students learn best from coordinated verbal and visual representations and when materials are designed according to evidence based principles such as signaling, segmentation, and coherence.[2] Dual Coding Theory further explains that paired visual–verbal teaching may strengthen encoding and retrieval.[3] Infographics (a visual representation of data or information that presents complex information quickly and clearly) are being increasingly used in health professions education as pedagogical tools that reorganize complex information into visually structured formats.[4] Well-designed infographics can act as scaffolds that make conceptual relationships clear and aid efficient revision. Narrative reviews describe infographics as tools that may enhance engagement, comprehension, and recall.[5] Research has begun to explore infographic-based learning in health education contexts.[6-9] However, much of the existing literature has focused on outcome measures or implementation reports, with limited qualitative exploration of how undergraduate medical students experience infographic-supported learning.[9,10]

Although infographics are increasingly used in health professions education as visual knowledge translation tools, most studies have focused on learning outcomes or implementation reports. Qualitative exploration of how medical students experience infographic-supported learning within routine pharmacology teaching remains limited. Understanding these experiences is essential to determine how visual learning tools influence cognitive processing, engagement, and revision strategies in content-dense disciplines such as pharmacology. The present study therefore examined Phase 2 MBBS students' experiences of infographic-supported pharmacology teaching across five major system blocks (ANS, autacoids, CVS, CNS, endocrine). Infographics were systematically developed, refined through expert consensus, and piloted prior to implementation. Using deductive thematic analysis, this study aimed to generate an in-depth account of how students reacted to infographic-based instruction in their everyday traditional lectures.

METHODS

Study design

This study used a qualitative descriptive design to explore Phase 2 (second-year) MBBS students' experiences of infographic-supported pharmacology teaching to generate a practice-oriented account of learner perceptions, usability, and perceived educational impact. Data were analyzed using a deductive thematic analysis following Braun and Clarke's six-phase framework, guided by an a priori analytic structure aligned with the study objectives.

Setting and educational context

The study was conducted in the Department of Pharmacology at All India Institute of Medical Sciences Patna among Phase 2 MBBS students participating in routine undergraduate pharmacology teaching between November 2025 and April 2026. The educational intervention consisted of infographic-supported teaching across five pharmacology system blocks: autonomic nervous system (ANS), autacoids, cardiovascular system (CVS), central nervous system (CNS), and endocrine pharmacology. Infographics were developed using AI-assisted tools and subsequently reviewed and verified by subject experts.

Development, expert validation, and pilot testing of infographics

Infographic development

Infographics were developed systematically in Notebooklm from standard curricular sources, verified by experts and aligned with predefined learning objectives for each of the chosen pharmacology systems. One infographic has been been provided in Supplementary (S1).

Expert validation using

Prior to implementation, the infographic sets underwent content validation through an expert validation process involving pharmacology educators and medical education experts from institutions across the country. Experts were purposively selected based on experience in undergraduate pharmacology teaching and educational design.

Five pharmacology experts evaluated the infographics using a structured review framework addressing content accuracy, conceptual clarity, visual organization, cognitive load, clinical relevance, and alignment with learning outcomes, based on a Likert score and subjective template provided to each. Qualitative feedback was anonymized, aggregated, and the infographics were iteratively revised based on expert recommendations. New infographics were designed based on expert comments by modifying the source and prompt given to notebooklm. Consensus was considered achieved when expert feedback demonstrated convergence and absence of substantive disagreement regarding adequacy and usability. The final infographic set reflected consensus-driven refinements. Across the five modules, a total of 25 validated infographics were integrated within the lecture presentations.

Departmental experts also reviewed the final presentations with embedded infographics, to audit the placement, number, and relevance to learning goals as well as cognitive load.

Pilot testing with students

Following expert validation, the one presentation with embedded infographic for every module was piloted with a small group of pharmacology residents. Pilot participants reviewed selected infographic sets and provided open-ended feedback on readability, clarity, and pacing. Minor refinements were incorporated to optimize visual density and instructional flow prior to full implementation.

Participants and sampling strategy

All students in the Phase 2 MBBS cohort who attended the infographic-supported sessions were invited to participate. A total of 125 students were exposed to the intervention, and anonymous narrative feedback was collected from those who consented to participate through the post-session survey. Because responses were collected anonymously to encourage candid reflection, individual demographic variables such as gender, prior academic performance, and prior exposure to infographic-based learning were not linked to the qualitative dataset. This limited subgroup comparison but supported confidentiality and reduced response inhibition.

Educational intervention

Students were sensitized to the purpose of the research, their role in it, and informed consent taken. Regular power point presentations were used where validated infographics were incorporated into teaching of the five pharmacology system blocks, taught by a panel of three teachers, involved in the research. During classroom sessions, infographics were projected and discussed interactively, followed by distribution of infographic materials for revision. A structured teaching log documented the number of infographics used, duration of time for which infographics were used per system to support procedural transparency. The lecture classes were primarily but not entirely infographic based.

Data collection

Data were collected after completion of the infographic-supported modules (one after each module) using an anonymous Google Form consisting primarily of open-ended questions designed to elicit reflective narrative responses. Because the objective was to capture broad learner experiences across an entire cohort rather than generate deeply interpretive individual narratives, open-ended survey responses were considered appropriate for qualitative descriptive analysis. Prompts explored students' overall learning experience, perceived strengths and limitations of infographic-based teaching, influence on understanding and retention, comparative usefulness across systems, and recommendations for improvement.

The anonymous survey included open-ended prompts designed to gather students' perceptions of infographic-supported teaching in pharmacology. These questions explored how the approach affected their understanding of pharmacology topics, what aspects of the infographics facilitated or hindered learning, and whether the use of infographics influenced their attention, engagement, or revision practices. Students were also asked to reflect on whether certain pharmacology systems were more suited to infographic-based teaching and to provide reasons for their views. In addition, they were invited to suggest improvements for the use of infographics in pharmacology education. All collected responses were analyzed collectively after the completion of all five modules.

Data management and confidentiality

The Google form was configured to preserve anonymity by avoiding collection of identifying information. Responses were exported to a password-protected dataset accessible only to the research team. Any inadvertent identifying details within narratives were removed during data cleaning. An audit trail documenting questionnaire versions, data preparation steps, and analytic decisions was maintained. Because feedback was collected anonymously without collection of identifying variables, detailed participant demographics were not available. However, all participants belonged to the same Phase 2 MBBS cohort exposed to the infographic-supported pharmacology sessions.

Researcher reflexivity

Because several investigators were also involved in designing and delivering the infographic-supported sessions, reflexive measures were adopted to reduce interpretive bias. The research team explicitly acknowledged the possibility that prior investment in the intervention could influence coding and theme interpretation. To address this, coding decisions were discussed iteratively, alternative interpretations were actively considered, and at least one reviewer not directly involved in classroom delivery contributed to analytic review. Attention was also paid to negative case analysis and to preserving participant comments that expressed reservations or preference for traditional learning formats.

Data analysis

Data were analyzed using deductive thematic analysis following Braun and Clarke's six-phase framework. An a priori coding framework was developed before analysis based on the study objectives and the theoretical constructs underpinning the intervention, particularly cognitive load, multimedia learning, and dual coding.

Although the analysis was deductively oriented, flexibility was maintained to accommodate divergent and unanticipated learner perspectives during theme refinement. Initial codes focused on conceptual clarity, engagement, cognitive load, learning utility, usability, and perceived retention. Student responses were read repeatedly for familiarization, coded using the predefined framework, and then iteratively reviewed to refine category boundaries and identify negative cases or responses that did not align fully with the initial structure. Themes were finalized through discussion among the research team, with emphasis on interpretive consistency and alignment with the research objectives.

Coding proceeded in three stages: first, initial assignment of responses to the predefined coding framework; second, refinement of codes through comparison across responses and identification of disconfirming or divergent views; and third, consolidation of codes into final themes through team discussion. Coding discrepancies were than resolved through discussion and revision of code definitions rather than calculation of inter-rater agreement statistics, consistent with a reflexive qualitative approach. The a priori coding framework used to guide the deductive thematic analysis is presented in Table 1.

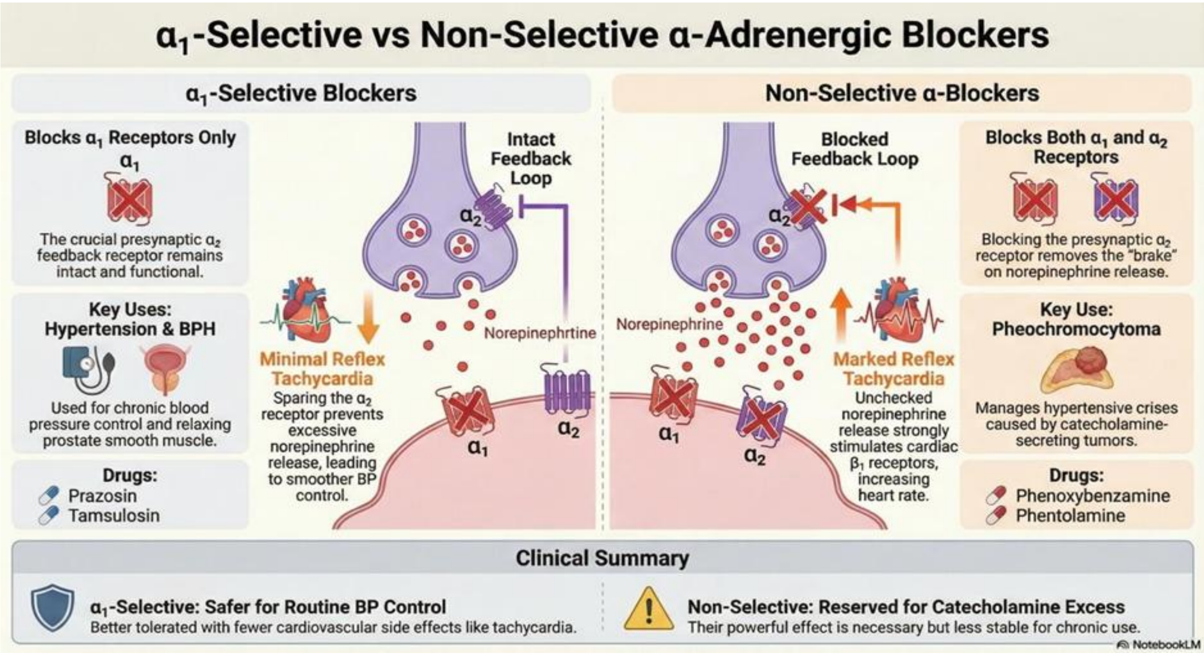

Figure 1: Infographic presentation of α_1-selective versus non-selective α-adrenergic blockers.

Ethical considerations

Institutional ethics approval was obtained prior to data collection. Informed consent was embedded within the Google Form. Participation was voluntary and anonymous, and academic standing was unaffected by participation. Data were stored securely and reported in aggregated de-identified form.

RESULTS

Analysis of students' narrative responses revealed a pattern of experiences around eight pre-defined deductive themes. Overall, students described infographic-supported teaching as a visually scaffolded learning approach that facilitated conceptual integration and revision efficiency, but also identified areas related to information density and pacing that required refinement.

Domain 1: cognitive learning impact

Theme 1: conceptual clarity

Students consistently described infographics as improving their understanding of mechanisms and helping them integrate pharmacological principles with clinical application. Visual sequencing of mechanisms of drug actions and comparisons between classes were suggested to be particularly helpful. Many participants said that the infographic format reduced fragmentation of information and allowed them to "see the whole picture" of drug action pathways. However, a small subset reported that oversimplification occasionally hid finer conceptual details.

Representative quotes

"*The diagrams helped me connect mechanisms and uses in a single glance. Earlier I memorized facts separately, but now I understand how they link*." (Student 3). "*Especially in ANS and CVS, the flow charts made receptor actions very clear. It felt like seeing the pathway instead of reading scattered points.*" (Student 11). "*Sometimes the simplification was very helpful, but in a few topics, I felt details were compressed too much that hampered deeper understanding*." (Student 22). "*Clinical correlations shown visually made it easier to remember why drugs are used, not just what they do*." (Student 34). "*For endocrine pharmacology, the infographics clarified feedback mechanisms that were confusing in textbooks*." (Student 47).

Theme 2: learning utility and retention

Students frequently associated infographics with improved recall and revision efficiency. Many described using the visuals as rapid review tools during exam preparation.

However, some participants reiterated that infographics complemented rather than replaced detailed textbook study.

Representative quotes

"*I used the infographics for quick revision before tests*." (Student 4). "*The visuals created memory cues that stayed longer than plain text notes*." (Student 16). "*They were excellent for last-minute revision, especially drug comparisons.*" (Student 27). "*Infographics are helpful summaries, but I still needed textbooks for deeper study*." (Student 39). *"Seeing the same visual repeatedly strengthened retention*." (Student 50).

Theme 3: system-specific differences

Students reported variation in perceived effectiveness across pharmacology systems. Mechanism-heavy systems such as ANS and CVS were widely considered most suited to infographic representation, whereas content-dense areas occasionally posed design challenges.

Representative quotes

"*ANS benefitted the most because receptor actions are easier to visualize."* (Student 7). *"CVS drugs became clearer when arranged visually by mechanism and class*." (Student 19). "*Autacoids were helpful but sometimes felt compressed due to many mediators*." (Student 32). "*CNS topics were useful visually, but some pathways were too dense to grasp quickly*." (Student 44). "*Endocrine feedback diagrams were particularly effective*." (Student 55).

Domain 2: learner engagement

Theme 1: engagement and motivation

Students reported increased attentiveness and interest during infographic-supported sessions. Visual elements were described as making traditionally dense pharmacology content easier to understand. However, few expressed that visual appeal could diminish over time if not combined with active discussion. Eight themes emerged from the deductive thematic analysis. For interpretive clarity, these themes were organized into three broader domains reflecting cognitive learning impact, learner engagement, and instructional design usability.

Representative quotes

"*I was able to pay attention throughout because the visuals kept changing and guiding the explanation*." (Student 6). "*Pharmacology usually feels heavy, but infographics made it more interesting and less scary*." (Student 18). *"It was easier to stay engaged compared to text-based slides*." (Student 29). "*After a few classes, I felt discussion matters as much as the visuals. Without explanation, images alone are not enough."* (Student 41). "*The colors and structure made me curious to explore the topic further after class*." (Student 52).

Domain 3: design and usability

Theme 1: cognitive load and information density

Students described mixed experiences regarding cognitive load. Many perceived infographics as reducing mental burden by organizing information spatially. Others noted that packed visuals occasionally produced visual fatigue.

Representative quotes

"*When information was distributed well, it felt easy to absorb. I could process one section at a time*." (Student 9). "*Some images were crowded, and I needed extra time to interpret everything shown."* (Student 21). *"Breaking large topics into smaller infographic segments helped reduce confusion."* (Student 35). *"At times I focused more on reading the infographic than listening to the explanation." (Student 48). "Clear visual hierarchy made complex drug lists feel manageable*." (Student 57).

Theme 2: usability and accessibility

Students discussed practical aspects of accessing and using infographics across devices. Most found them readable and convenient for mobile revision, though font size and resolution occasionally affected usability.

Representative quotes

"I could easily revise on my phone, which made studying flexible." (Student 5). *"Some text appeared small on mobile screens and needed zooming*." (Student 14). *"The layout was clean and readable when shared as PDFs."* (Student 26). *"High contrast colors improved visibility during projection."* (Student 37). *"Consistent formatting helped me recognize patterns across topics*." (Student 49).

Theme 3: critical perspectives

Although the dominant pattern of responses was positive towards infographic-supported teaching, a subset of students expressed reservations

Representative quotes

"Sometimes I spent more time trying to understand the layout of the infographic than listening to the teaching." (Student 8). "*When too many drugs were shown in one diagram, it became visually taxing and harder to focus."* (Student 17*). "I felt that crowded images made me anxious because I was trying to read everything quickly."* (Student 31).

Another set of responses suggested that infographic summaries might encourage superficial learning if used in isolation. These students emphasized the continued importance of detailed textual study and expressed caution about overreliance on visual condensation. *"Infographics are helpful for overview, but if I depend only on them, I might miss important details needed for deeper understanding."* (Student 12). *"They are good revision tools, but textbooks are still necessary to fully grasp complex topics."* (Student 26). *"I feel that simplified visuals can sometimes hide finer details that are important for exams."* (Student 43). A small subset of participants expressed a preference for traditional text-based or note-driven learning formats. These students described familiarity and perceived precision as advantages of conventional materials and suggested that infographic learning may not align equally with all cognitive styles. *"I am more comfortable learning from written notes because I can follow the sequence step by step."* (Student 5). *"Visual formats are interesting, but I personally retain better from structured text."* (Student 21). *"Infographics are engaging, but they do not replace the clarity I get from detailed reading."* (Student 37).

Domain 4: recommendations

Theme: recommendations for improvement

Students provided constructive suggestions focusing on optimizing density, pacing, and integration with the active learning strategies.

Representative quotes

"Dividing dense infographics into multiple slides would improve clarity." (Student 10). *"Including short pauses for discussion helped reinforce learning."* (Student 23). *"Interactive elements like quizzes after each infographic could deepen understanding."* (Student 36). *"Adding legends or icons explanations would make visuals more intuitive."* (Student 45). *"Maintaining the same structure across all systems should continue."* (Student 58). *"All infographics to be given separately, for rapid revision."* (Student 97).

Integrative synthesis

Students concluded that infographic-supported teaching was a cognitively supportive scaffold that enhanced conceptual clarity, engagement, and revision efficiency. While visual organization reduced perceived complexity, optimal pacing and information density emerged as critical determinants of effectiveness. Learners emphasized that infographics functioned best as integrated pedagogical tools combined with guided explanation and active discussion.

Table 1: Deductive coding framework used for thematic analysis.

Preliminary code/theme	Operational definition	Illustrative analytic focus	Theoretical basis
Conceptual clarity	Perceived improvement in understanding of pharmacological mechanisms, relationships, or clinical applications	Mechanism–use linkage, pathway understanding, reduction in fragmented learning	Cognitive Load Theory
Engagement and motivation	Perceived increase in attention, interest, or active involvement during learning	Attention during class, interest in topic, reduced monotony	Cognitive Theory of Multimedia Learning
Cognitive load and information density	Perceptions of mental effort, overload, visual fatigue, or ease of processing	Dense visuals, pacing, readability, mental burden	Cognitive Load Theory
Learning utility and retention	Perceived usefulness of infographics for recall, revision, and memory support	Rapid revision, memory cues, exam preparation	Dual Coding Theory
System-specific suitability	Variation in usefulness across pharmacology topics or systems	ANS, CVS, CNS, endocrine, autacoids	Instructional alignment with content structure
Usability and accessibility	Practical ease of using infographics across devices and contexts	Font size, mobile viewing, layout consistency	User-centered instructional design
Critical perspectives	Negative or cautionary perceptions regarding infographic-supported teaching	Superficial learning, distraction, preference for text	Negative case analysis

Continued.

Preliminary code/theme	Operational definition	Illustrative analytic focus	Theoretical basis
Recommendations for improvement	Suggestions to optimize infographic design or teaching integration	Segmentation, legends, pauses, interactive use	Applied educational design

Codes were derived a priori from the study objectives and theoretical constructs related to cognitive load, multimedia learning, and dual coding, and were refined iteratively during analysis.

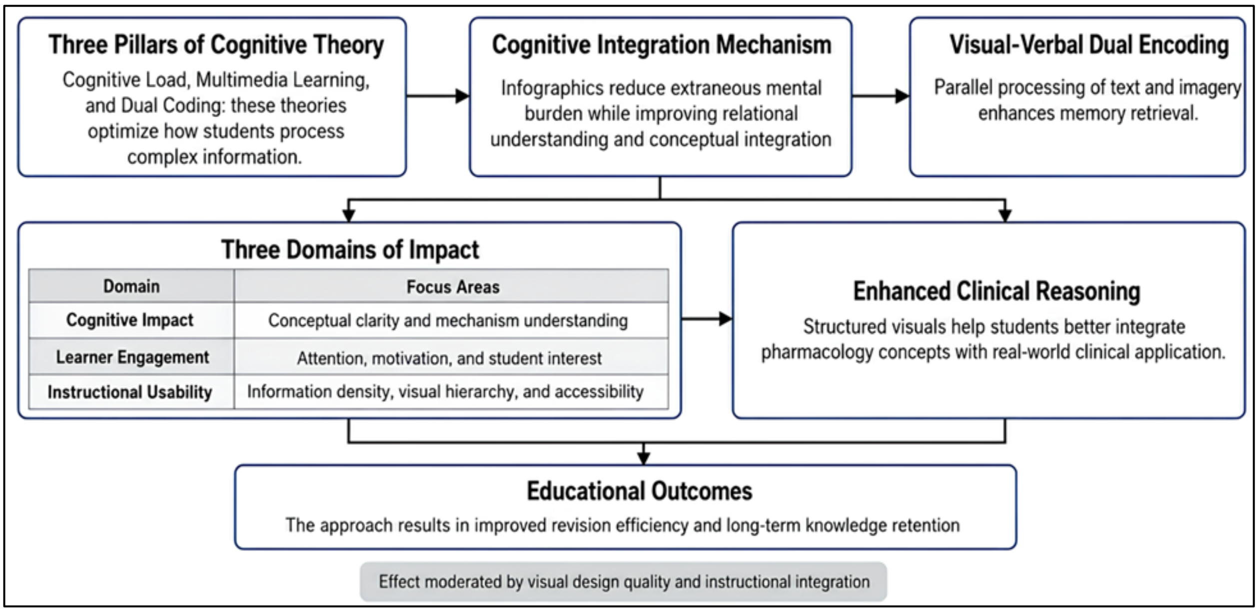

Figure 2: The cognitive framework of infographic supported learning.

Variations across pharmacology systems highlighted the importance of adapting visual design to content structure. Collectively, the findings suggest that validated infographic-based instruction can serve as a powerful adjunct to pharmacology education when aligned with principles of cognitive load management and interactive pedagogy. These interrelated findings were further synthesized into a conceptual framework linking theoretical constructs with learner-reported outcomes (Figure 2).

DISCUSSION

This study provides qualitative evidence that infographic-supported pharmacology teaching was experienced by students as a visual learning tool that supported conceptual integration, engagement, and revision efficiency. Participants consistently described that infographics helped them connect drug mechanisms, classifications, and clinical applications. This pattern aligns with predictions from Cognitive Load Theory, which suggests that learning improves when instructional design reduces fragmentation and allows working memory to focus on schema construction.[1] By presenting relationships spatially, the infographics appeared to facilitate conceptual organization and relational understanding beyond rote memorization.

These findings suggest that infographic-supported teaching can function as a visual scaffold in pharmacology education, particularly for mechanism-driven topics such as autonomic and cardiovascular pharmacology, when combined with instructor guidance and discussion rather than used as standalone summaries.

The findings are also consistent with the Cognitive Theory of Multimedia Learning and Dual Coding Theory, which propose that coordinated visual and verbal representations enhance comprehension and recall.[2,3] Students frequently described visual elements functioning as anchors during revision. However, some participants noted that overly dense infographics increased cognitive strain and diverted attention from instructor explanations. These observations align with established multimedia design principles indicating that visual complexity can increase extraneous cognitive load when information density exceeds processing capacity. Effective infographic design therefore requires segmentation of complex information and alignment with instructional pacing.

Educational research in pharmacology and biomedical sciences similarly highlights the value of structured visual representations for mechanism-based learning. Studies on concept mapping and visual schema construction demonstrate that graphical representation of causal relationships can improve learners' ability to integrate receptor signaling pathways, drug mechanisms, and clinical outcomes.[15-17] These findings mirror the experiences reported by students in the present study, who described infographics as tools that helped them visualize mechanisms of action and link pharmacological principles with therapeutic applications.

Our findings also extend existing literature on infographic-based learning in health professions education. Previous studies have suggested that infographics can enhance learner engagement, comprehension, and knowledge translation when designed with pedagogical intent rather than aesthetic emphasis alone.[5] Empirical work in medical and nursing education has likewise reported improved learner motivation and perceived learning value associated with infographic-supported teaching or infographic-generating activities.[6-8] The present study adds a qualitative perspective by illustrating how learners actively incorporate infographics into their study strategies, particularly as revision tools and conceptual organizers.

The role of infographics in health communication and knowledge translation has also received increasing attention in recent years. Infographics can condense complex scientific information into visually structured formats that facilitate rapid comprehension and recall.[18-20] Students in the present study similarly reported that infographic summaries supported efficient revision and improved recall of pharmacological concepts, suggesting that visual summaries may function as cognitive shortcuts during examination preparation.

Importantly, the findings also indicate that infographic-supported instruction is not universally optimal. Some students preferred traditional text-based learning materials or experienced visual fatigue when diagrams were crowded.[9-11] These perspectives reinforce the need to view infographics as complementary pedagogical tools rather than replacements for detailed textual study. Their educational value appears greatest when integrated with instructor explanation and active classroom discussion, allowing educators to contextualize and clarify visual representations.

The systematic development process used in this study—including expert validation and pilot testing—likely contributed to the perceived coherence and usability of the infographics. Student feedback highlighted several practical design principles for infographic-based teaching: maintaining clear visual hierarchy, limiting information density, segmenting complex topics across multiple visuals, and using consistent iconography to support pattern recognition.[11-14] These strategies are consistent with established multimedia learning guidelines and may help optimize visual instructional resources in pharmacology education.

While the present findings demonstrate perceived educational value, further research is needed to examine long-term learning outcomes associated with infographic-supported teaching. Future studies should explore effects on knowledge retention, clinical reasoning, and transfer of pharmacological knowledge to clinical decision-making. Mixed-methods approaches combining learner experience with objective performance measures may provide a more comprehensive evaluation of infographic-based teaching strategies.

To integrate these findings with established learning theories, we propose a conceptual framework illustrating the cognitive mechanisms underpinning infographic-supported pharmacology learning (Figure 2). The framework synthesizes principles from cognitive load theory, multimedia learning, and dual coding theory to explain how structured visual representations reduce extraneous cognitive load, facilitate relational understanding, and enable parallel visual–verbal encoding. These processes collectively enhance conceptual integration and support clinical reasoning. The model also incorporates learner-reported domains of impact, including cognitive clarity, engagement, and instructional usability, ultimately linking instructional design features with improved revision efficiency and knowledge retention. Importantly, the framework highlights that these effects are moderated by visual design quality and integration within active teaching strategies, consistent with the negative case findings in this study.

Educational implications

The findings of this study have several practical implications for pharmacology education. Infographic-supported teaching appears particularly useful for mechanism-intensive topics, such as autonomic pharmacology, cardiovascular pharmacology, and endocrine feedback pathways, where understanding relationships between receptors, signaling pathways, and therapeutic effects is essential. Students frequently reported using infographics as rapid revision tools, suggesting that visually structured summaries may facilitate consolidation of pharmacological knowledge during examination preparation.

From a curriculum perspective, infographics may therefore serve as visual scaffolds that complement traditional lectures and textbooks, helping learners organize complex information while maintaining conceptual coherence. However, effective implementation requires careful attention to visual design, including segmentation of complex information, consistent visual structure, and alignment with instructional pacing. These principles reflect established multimedia learning guidelines emphasizing the importance of minimizing extraneous cognitive load while supporting schema development.[21,22]

Limitations

This study has several limitations. First, findings are based on self-reported experiences from a single institutional cohort, which may limit generalizability. Second, qualitative responses may be influenced by social desirability bias despite anonymity measures. Also, variability in individual exposure and engagement with infographics outside classroom settings could not be controlled. Additionally, the use of open-ended survey responses rather than interviews or focus groups may have limited the depth of qualitative insight. As this study used open-ended survey responses from a complete student cohort rather than iterative interviews or focus groups, thematic sufficiency was judged pragmatically based on the breadth and recurrence of patterns across responses rather than formal saturation in the traditional qualitative sense. The study relied primarily on self-reported learner perceptions and did not triangulate findings with objective outcome measures such as assessment scores, classroom engagement metrics, or retention testing. Certain COREQ domains applicable to interview-based qualitative studies, such as member checking and repeat interviews, were not applicable because data were collected anonymously through open-ended survey responses. Future mixed-methods studies should integrate subjective and performance-based data to strengthen inference. Because responses were collected anonymously, participant-level characteristics such as gender, prior academic performance, and familiarity with infographic-based learning could not be examined in relation to the themes.

Strengths

Despite these limitations, the study provides a large cohort qualitative exploration of infographic-supported pharmacology teaching integrated within routine undergraduate instruction. The systematic development, expert validation and pilot testing of the infographics enhance the credibility of the intervention and provide practical insights for pharmacology educators.

CONCLUSION

Infographic-supported teaching was perceived by undergraduate medical students as a valuable adjunct to pharmacology education that facilitated conceptual integration, enhanced learner engagement, and improved revision efficiency. Students particularly valued the ability of visual representations to connect mechanisms of action with clinical applications and to organize complex information into coherent structures. However, the findings also highlighted the importance of careful instructional design, as excessive visual density and overreliance on simplified summaries could limit their effectiveness. These observations suggest that infographics are most beneficial when integrated with guided explanation and interactive teaching rather than used as standalone resources. Overall, systematically designed and validated infographics may serve as effective visual scaffolds that complement conventional teaching and support meaningful learning in content-intensive disciplines such as pharmacology. Further mixed-methods and multi-institutional studies incorporating objective learning outcomes are warranted to better understand their long-term educational impact.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Sweller J. Cognitive load during problem solving: Effects on learning. Cogn Sci. 1988;12(2):257-85.
2. Mayer RE. Multimedia Learning. 2nd ed. Cambridge: Cambridge University Press. 2009.
3. Paivio A. Dual coding theory: Retrospect and current status. Can J Psychol. 1991;45(3):255-87.
4. Dunlap JC, Lowenthal PR. Getting graphic about infographics: design lessons learned from popular infographics. Educause Rev. 2016;51(6):42-55.
5. Balkac M, Ergun E. Role of Infographics in Healthcare. Chin Med J (Engl). 2018;131(20):2514-7.
6. Scott H, Fawkner S, Oliver CW, Murray A. Why healthcare professionals should know a little about infographics. Br J Sports Med. 2016;50:1104-5.
7. Chan AKM, Nickson CP, Rudolph JW, Lee TC, Joynt GM. social media for rapid knowledge dissemination. Anaesthesia. 2020;75:1579-82.
8. Alhadad SSJ. Visualizing data to support judgement, inference, and decision making in learning analytics. Comput Hum Behav. 2018;89:296-304.
9. McCrorie AD, Donnelly C, McGlade KJ. Infographics: Healthcare Communication for the Digital Age. Ulster Med J. 2016;85(2):71-5.
10. Kong HK, Zainab F, Turner AM, Bekemeier B, Backonja U. Trends in and Effectiveness of Infographics for Health Communication: A Scoping Review. Health Commun. 2025;40(2):222-32.
11. McSween-Cadieux E, Saha T, Chabot C, Fillol A, Hot A, Haddad R, et al. A Scoping Review on the Use of Infographics as a Health-Related Knowledge Translation Tool. Health Commun. 2025;40(12):2717-29.
12. Cook DA, Ellaway RH. Evaluating technology-enhanced learning. Med Teach. 2015;37:961-70.
13. Beecher B, O'Doherty A, Goulao B, Jalali A, Salsberg J, Dore L, et al. Designing infographics in health research with patients and the public: A scoping review protocol. PLoS One. 2023;18(9):e0291066.
14. Cima L, Das A, Dhanasekaran V, Mirabassi N, Pagliuca F. The "Make Surgical Pathology Easy" project: learning Pathology through tailored digital infographics - the case for renovation of an old teaching method. Pathologica. 2021;113(4):252-61.
15. Novak JD, Cañas AJ. The theory underlying concept maps and how to construct them. Technical Report IHMC CmapTools. Pensacola: Institute for Human and Machine Cognition. 2008.

16. Daley BJ, Torre DM. Concept maps in medical education: an analytical literature review. Med Educ. 2010;44(5):440-8.
17. Torre DM, Daley BJ, Sebastian JL, Elnicki DM. Overview of current learning theories for medical educators. Am J Med. 2006;119(10):903-7.
18. Smiciklas M. The Power of Infographics: Using Pictures to Communicate and Connect with Your Audiences. Indianapolis: Que Publishing. 2012.
19. Krum R. Cool Infographics: Effective Communication with Data Visualization and Design. Indianapolis: Wiley. 2013.
20. Tufte ER. The Visual Display of Quantitative Information. Cheshire: Graphics Press. 2001.
21. Mayer RE, Fiorella L. Principles for reducing extraneous processing in multimedia learning. Cogn Sci. 2014;38:1327-45.
22. Van Merriënboer JJG, Sweller J. Cognitive load theory in health professional education. Med Educ. 2010;44:85-93.

Cite this article as: Singh S, Meena RK, Singh PK, Shee S. Infographic-supported pharmacology teaching in undergraduate medical education: a qualitative study of student experiences. Int J Basic Clin Pharmacol 2026;15:674-83.